

AMENDMENTS TO THE CLAIMS

This complete listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Original) A rate controller for a block-based video encoder, comprising:
 - a variable bit rate (VBR) controller generating a first quantization step size;
 - a constant bit rate (CBR) controller generating a second quantization step size; and
 - a selector configured to select a maximum permissible quantization step size from said first quantization step size and said second quantization step size for use by a quantizer in quantizing transform data.
2. (Original) The rate controller of claim 1, further comprising:
 - an input for processing at least one parameter of operation for at least one of said VBR controller and said CBR controller.
3. (Original) The rate controller of claim 2, wherein said at least one parameter includes at least one of a target peak bit rate, a target average bit rate, a maximum quantization scale, a minimum quantization scale, a target quantizer scale, a target buffer scale, a VBV buffer size, and a time constant for said VBR rate controller to track changes in long-term average bit rate.
4. (Currently Amended) The rate controller of claim 1, wherein an average bit rate of said VBR controller tracks variations in long-term average bit rate of an output bit stream of said block-based video ~~compression~~ encoder.
5. (Original) The rate controller of claim 4, wherein said VBR controller comprises a proportional integral controller adapted for tracking variations in long-term average bit rate.

6. (Original) The rate controller of claim 5, wherein said VBR controller includes a programmable time constant for adapting to changes in long-term average bit rate.

7. (Original) The rate controller of claim 1, wherein said CBR controller comprises:

- a picture analysis module configured to classify macroblocks of a current picture into at least two different macroblock types and calculate a statistical indicator of complexity for each macroblock type;

- a complexity model module coupled to said picture analysis module configured to form a predicted picture complexity estimate based on a statistical frequency of said macroblock types within said current picture;

- a bit allocation module adapted to form a bit allocation consistent with said predicted picture complexity estimate; and

- a picture-level quantizer assignment module adapted to assign a quantization step size consistent with said bit allocation.

8. (Original) The controller of claim 7, wherein said indicator of complexity comprises an energy value calculated from an activity measurement of macroblocks.

9. (Original) The controller of claim 7, wherein said bit allocation module comprises:

- an ideal bit allocation module configured to calculate an ideal bit allocation based on an estimated complexity of a picture;

- a video bitstream verification (VBV) fullness adjustment module configured to adjust said ideal bit allocation to maintain a desired VBV buffer fullness range; and

- a VBV compliance adjustment module configured to adjust said ideal bit allocation to maintain VBV compliance.

10. (Original) A constant bit rate controller for a video compression encoder, comprising:

- a picture analysis module configured to determine a statistical frequency of each of at least two different types of macroblocks within a current picture and for forming at least one statistical indicator of the complexity of each of said at least two different types of macroblocks;

a complexity model module coupled to said picture analysis module configured to form a predicted picture complexity estimate based on statistics of said macroblocks;

a bit allocation module adapted to form a bit allocation consistent from said predicted picture complexity estimate; and

a picture-level quantizer assignment adapted to assign a quantization step size consistent with said bit allocation.

11. (Original) The constant bit rate controller of claim 10, wherein said bit allocation module comprises:

an ideal bit allocation module configured to calculate an ideal bit allocation based on an estimated complexity of a picture;

a video bitstream verification (VBV) fullness adjustment module configured to adjust said ideal bit allocation to maintain a desired VBV buffer fullness range;

a VBV compliance adjustment module configured to adjust said ideal bit allocation to maintain VBV compliance.

12. (Original) The constant bit rate controller of claim 10, wherein said at least one statistical indicator of said picture analysis module comprises: an energy value for each macroblock type.

13. (Original) The constant bit rate controller of claim 12, wherein each energy value is determined by a calculation including: a difference measurement of each macroblock type between original pixel luminance values and mean pixel luminance values.

14. (Original) The constant bit rate controller of claim 10, wherein said at least one statistical indicator of said picture analysis module comprises a time averaged energy estimate for at least one macroblock type.

15. (Original) The constant bit rate controller of claim 10, wherein said complexity model module generates a measurement of the complexity of each type of macroblock and a running estimate of macroblock type complexities.

16. (Currently Amended) A method of constant bit rate (CBR) rate control in a video compression encoder, comprising:

for a current picture, determining a statistical frequency of macroblock types;
generating a statistical indicator indicative of a complexity of each type of macroblock;
predicting picture complexity to form a predicted picture complexity by forming a weighted sum of macroblock types, wherein each macroblock type has a weight that increases with its statistical frequency and with a value of said statistical indicator; and
generating a bit allocation consistent with said predicted picture complexity; and
assigning a quantizer step size consistent with said bit allocation.

17. (Original) The method of claim 16, wherein said generating a statistical indicator comprises:
calculating a difference measurement of each macroblock type between original pixel luminance values and mean pixel luminance values.

18. (Original) The method of claim 17, further comprising:
for each macroblock type, forming an energy value by scaling a corresponding difference measurement value by an empirical factor and averaging scaled difference measurement values over all macroblocks of the same type in said current picture.

19. (Currently Amended) The method of claim 18, further comprising: utilizing a macroblock aging ~~parameter~~ parameter to generate a time averaged energy estimate for at least one macroblock type.

20. (Original) The method of claim 19, further comprising: generating a measurement of the complexity of each type of macroblock.

21. (Original) The method of claim 18, further comprising: generating a running estimate of macroblock type complexities.

22. (Original) The method of claim 21 wherein said generating a running estimate of macroblock type complexities comprises: combining macroblock complexities for a current picture with values of a previous picture.
23. (Original) The method of claim 18, wherein said values of said previous picture are weighted by an aging factor.
24. (Original) The method of claim 16, further comprising: generating an intra energy output for bit prediction in a video bitstream compliance check.
25. (Original) The method of claim 24, further comprising: measuring the intra energy for a current picture and combining it with a measure of the intra-energy for a previous picture.
26. (Original) The method of claim 25, wherein said measure of the intra-energy for said previous picture is weighted by a picture level aging parameter.
27. (Original) A method of variable bit rate control in a video compression encoder having a variable bit rate controller with a peak bit rate and a selectable average bit rate, comprising:
 measuring changes in long-term average bit rate of an output bitstream of said encoder;
 and
 adjusting said average bit rate of said variable bit rate controller to track said changes in long-term average bit rate.
28. (Original) The method of claim 27, wherein said adjusting comprises:
 adapting to said changes in long-term average bit rate according to a time constant.
29. (Original) The method of claim 27, wherein said adjusting comprises:
 adapting to said changes in long-term average bit rate according to a proportional integral controller response.

22. (Original) The method of claim 21 wherein said generating a running estimate of macroblock type complexities comprises: combining macroblock complexities for a current picture with values of a previous picture.

23. (Original) The method of claim 18, wherein said values of said previous picture are weighted by an aging factor.

24. (Original) The method of claim 16, further comprising: generating an intra energy output for bit prediction in a video bitstream compliance check.

25. (Original) The method of claim 24, further comprising: measuring the intra energy for a current picture and combining it with a measure of the intra-energy for a previous picture.

26. (Original) The method of claim 25, wherein said measure of the intra-energy for said previous picture is weighted by a picture level aging parameter.

27. (Original) A method of variable bit rate control in a video compression encoder having a variable bit rate controller with a peak bit rate and a selectable average bit rate, comprising:

measuring changes in long-term average bit rate of an output bitstream of said encoder;

and

adjusting said average bit rate of said variable bit rate controller to track said changes in long-term average bit rate.

28. (Original) The method of claim 27, wherein said adjusting comprises:

adapting to said changes in long-term average bit rate according to a time constant.

29. (Original) The method of claim 27, wherein said adjusting comprises:

adapting to said changes in long-term average bit rate according to a proportional integral controller response.

30. (Currently Amended) A method of rate control in a video compression encoder, comprising:

generating a first quantization step size using a constant bit rate encoder;
forming a second quantization step size using a variable bit rate encoder; and
selecting a maximum quantization step size from said first quantization step size and said second quantization step size for use in quantizing compressed video image data.

31. (Original) The method of claim 30, wherein said forming comprises:
tracking long-term average bit rates.

32. (Original) The method of claim 30, wherein said forming comprises:
tracking long-term average bit rates using a proportional integral encoder.